BIBLIOMETRIC EVALUATION OF SCIENTIFIC LITERATURE IN THE AREA OF RESEARCH IN EDUCATION USING INCITES™ DATABASE OF THOMSON REUTERS

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Abstract

Introduction

InCites™ uses data from seven editions of the Thomson Reuters Web of Science™ Core Collection for its publication counts and indicators. InCites™ is currently the only available tool that allows to aggregate data concerning citations that would be divided into areas, journals and scientific institutions, using multi-criteria search. Contrary to such database as Scopus® or Google Schoolar, InCites™ offers a much broader range of analytical possibilities and creating bibliometric statements.

Aim of study

Bibliometric evaluation of scientific literature in the field of research in education.

Materials and Methods

InCites™ bibliometric database was used for analysis; it collects data concerning citations that come from, e.g. *Science Citation Index*, *Social Science Citation Index*®, and *Arts and Humanities Citation Index*®. *Educational Research* (ER), *Educational Psychology* (EP), and *Education - Scientific disciplines* (ES), these are categories for which InCites™ database sees the possibility of reporting the citation index. Citations from the years of 2004-2014 for three above mentioned categories were evaluated. In total, there were 237 692 documents and 680 279 citations included in the source data.

Impact factor values for the most renowned journals and publications, and the number of citations for the best research centres (universities and other institutions that focus on a combination of education and research) that operate in the field of research in education worldwide were compared.

Results

From among the analysed journals, the ones of most great impact factor were: *Child Development* (35 385, category of EP), *Academic Medicine* (29 704, category of ES) and *Computers & Education* (20 416, category of ER). From among the scientific institutions that have the strongest position in the field of research in education, the following could be listed: University of California System and Pennsylvania Commonwealth System of Higher Education (citations were 33 488 and 20 134 respectively). Among publications that were of the highest impact factor in individual categories, the following drew attention: Preacher KJ et al. (Journal Of Educational And Behavioral Statistics 2006; 31(4):437-448); Frazier PA et al. (Journal Of Counseling Psychology 2004; 51(1): 115-134); Issenberg S Bet al. (Medical Teacher 2005; 27(1): 10-28) with citations of 789 (category of ER), 1015 (category of EP) and 636 (category of ES) respectively. Moreover, a detailed analysis of individual publications, shows that participation of American research centres dominates considering the overall number of citations in this discipline of science. Most broadly disputed issues include methodology of research in psychology and education, and publications concerning educational diagnostics and evaluation of various methods of teaching.

Conclusions

Results of bibliometric analysis allow to determine the direction of research development in the field of education, point out the most important tendencies and interests of the scientific circles in this area. Such analyses may also be helpful when planning future research strategies, they may also become a valuable source of information for scientists seeking co-partners. Organising network research group

may be based on data concerning interests and scientific achievements of certain groups or institutions coming from different countries or continents.

Keywords: bibliometrics, scientometrics, educational research, impact factor, citation analysis, disciplinarity index.

1 INTRODUCTION

The development of science is inextricably linked to the exchange of information among scholars interested in the same subject, as well as its sharing with world-wide public. Since printing has become a common carrier of information, the publishing market develops intensively together with growing number of publications and journals. The increase in number of the publications caused creation of a new publishing house which would publish summaries of published research and would allow acquisition of the whole literature in a field (eg. *Current Contents, Excerpta Medica, Index Medicus*) [1]. The subsequent development of computer technology improved publishing process and allowed processing of information and its dissemination through computer networks, as available *online* bibliography and abstract databases (eg. *Medline, Scopus, Web of Science*) [2].

Scientific journals, due to their short publishing time, in the 20th century became the primary media of communication between scientists. The speed of dissemination of research results is important for fast developing fields of science and hence the growing role of journals as publication space for the latest data [3]. The creation of electronic journals shortened even more the path between senders and receivers, as in the case of publishing articles in electronic versions of journals (more often existing only in the electronic version) the time needed for printing and sending each journal issue to subscribers is eliminated. Even a cursory look at the bibliography attached to articles indicates the ever-growing position of magazines as a media of communication between scholars [4].

The term "bibliometrics" was first used by Alan Pritchard in 1969 and defined as "*the application of mathematical and statistical methods to books and other media of communication*" [5]. More recent definitions define "bibliometrics" as "*the quantitative study of state and development trend of literature using a statistical method on a base of bibliographical descriptions or publisher statistics*". Most of the currently published bibliometric analysis is primarily based on data obtained from Thomson Reuters databases, that is different citation indexes, e.g.: *Science Citation Index, Social Science Citation Index, Arts & Humanities Citation Index*, and statistical publishing such as Journal Citation Reports®. In addition, in 2014 Thomson Reuters released for testing three new databases aggregating data from *Citation Indexes* for bibliometric analysis purposes: InCites™, Essential Science Indicators, and a new version of Journal Citation Reports®. InCites™ is currently the only available tool that allows aggregation of citation data divided into scientific disciplines, magazines, and research using multi-criteria search. In contrast to databases such as Scopus® or Google Schoolar, InCites™ offers a much wider range of analytical capabilities and tools for obtaining bibliometric statements [6].

A growing number of journals forces thorough evaluation and constant verification of their quality. Such evaluations have become very important for different groups of users who, due to the large number of available titles, must make the necessary selection. On one hand, scientists want to know which articles are worth reviewing in order to follow recent research results and keep up to date in the area of their interests. On the other hand, it is important to choose a right place for publication of research results to reach the widest possible range of people involved in a field. The problem of evaluating journals is also very important for libraries which must make decisions about subscriptions. Also, the institutions involved in financing and settlement of research grants use scientometric analysis which help evaluate the scientific achievements of researchers [7, 8]. In Poland, for instance, it is planning to base allocation of government funds for university research to a large extent on bibliometric indicators. Therefore, each year there is an increasing number of papers using bibliometric methods and scientometric analysis of the literature and science assessments [9]. Recent information related to bibliometric analysis, or more broadly speaking scientometric, is reflected in publications devoted to this subject. In particular, the example of such magazines are: *Journal of the American Society and Information Science, Information Processing and Management, Journal of Documentation, Journal of Information Science,* and *Research Policy*.

2 AIM OF STUDY

The aim of this study is bibliometric evaluation of scientific literature in the field of educational research.

3 MATERIALS AND METHODS

For the analysis, Thomson Reuters InCites™ bibliometric database was used which collects data on the number of citations. InCites™ uses data from seven editions of the Thomson Reuters Web of Science™ Core Collection for its publication counts and indicators. These seven editions represent more than 12 000 journals, 12 000 annual conferences and 53 000 scholarly books:

- Science Citation Index Expanded (SCIE),
- Social Science Citation Index (SSCI),
- Arts & Humanities Citation Index (AHCI),
- Conference Proceedings Citation Index - Science (CPCI-S),
- Conference Proceedings Citation Index - Social Science & Humanities (CPCI – SSH),
- Book Citation Index - Science (BKCI-S),
- Book Citation Index - Social Sciences & Humanities (BKCI-SSH).

Currently source publications from 2004-2014 are used within InCites™, and all document types are included. Data and baselines are updated every two months [6].

In the field of educational research, InCites™ database provides the possibility to report citation index for three categories: *Educational Research* (ER), *Educational Psychology* (EP), and *Education - Scientific disciplines* (ES). Literature citations were evaluated for the years 2004-2014, for the three above categories. In total, the raw data consisted of 237,692 documents and 680,279 citations (Fig. 1). Citation indexes were analysed for the best research centres in the world (universities and other institutions that focus on a combination of education and research), which operate in the field of educational research. The impact of individual journals was estimated on the basis of the global number of citations of all publications from the same source. For a comparative analysis of 5-Year Impact Factorfor magazines from three categories used a non-parametric Kruskal-Wallis ANOVA rank test for independent groups with *post hoc* test of multiple comparisons of average rank. Furthermore, the same tools of statistical analysis were used for assessment of the most influential scientific publications in the field of educational research by the comparison of the citation number in each category.

In calculations, STATISTICA 10.0 (StatSoft, Inc.) was used according to Medical University of Warsaw licence. For all analyses, the relevance level assumed *a priori* was $\alpha = 0.05$.

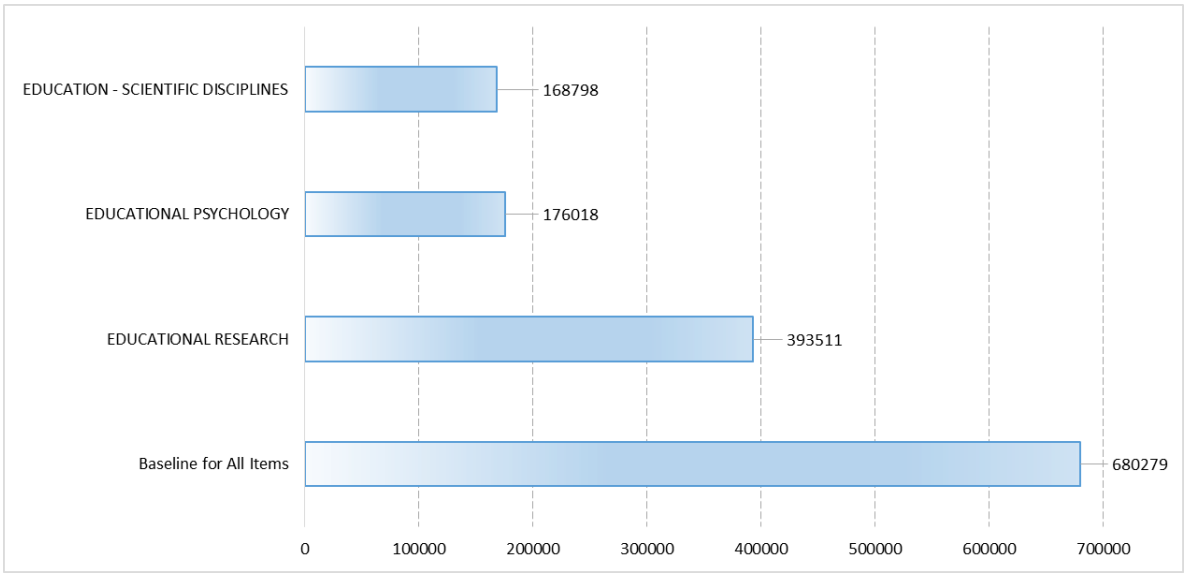

Figure 1. Comparison of the number of citations between 2004-2014 with regard to thematic categories, according to which InCites™ database indexes publications in the field of educational research

4 RESULTS

Of the global number of indexed citations in the field of educational research (680,279), about 13.7% of all citations (93,164) was gathered by five American research centres. Most of the cited papers were created by authors coming from academic centres. Comparison of the number of citations including research centres, according to which InCites™ database indexes publications in the field of educational research is presented in Fig. 2.

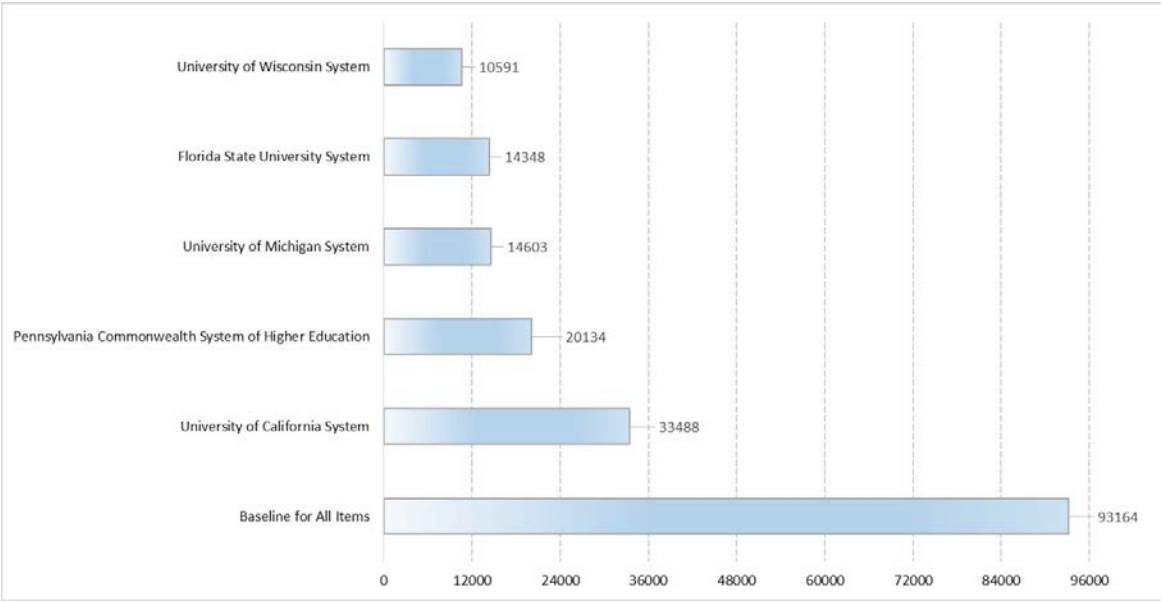

Figure 2. Comparison of the number of citations including research centres, according to which base InCites™ database indexes publications in the field of educational research

Analysis of the most influential journals in the field of educational research indicates a total of nine titles, three in each category, with the higher number of citations between 2004-2014. These journals have a high index of cited publications, which means small number of articles which have never been cited. Furthermore, for three journals observed overall high citation calculated as times per documents cited. Among these magazines there can be distinguished: *Child Development, Journal of Educational Psychology,* and *Journal of Counseling Psychology*. Comparison of journals with the highest number of citations of articles published between 2004-2014 indexed by Web of Science™ Core Collection database is presented in Table 1.

Table 1. Comparison of journals with the highest number of citations of articles published between 2004-2014 indexed by Web of Science™ Core Collection database

1	Web of Science documents	Times cited	Times cited per documents	% Documents cited	Category
Child Development	1 356	35 385	26	89%	Educational Psychology
Academic Medicine	3 443	29 704	9	70%	Education - Scientific disciplines
Computers & Education	1 933	20 416	11	81%	Educational Research
Journal of Educational Psychology	678	17 086	25	92%	Educational Psychology
Medical Teacher	2 677	13 700	5	67%	Education - Scientific disciplines
Journal of Chemical Education	4 374	12 263	3	63%	Education - Scientific disciplines

Journal of Counseling Psychology	531	11 149	21	87%	Educational Psychology
Health Education Research	932	10 565	11	85%	Educational Research
Teaching and Teacher Education	1 267	9 162	7	79%	Educational Research

A comparative analysis of the impact of magazines in various categories of educational research indicates that the titles in the *Educational Psychology* group have statistically significantly higher values for 5-Year Impact Factor (average of ranks 168.9) than observed for the *Education - Scientific disciplines* and *Educational Research* group (average of 147.2 and 123.9 ranks, respectively; ANOVA Kruskal-Wallis rank test H = 14.35, $P = 0.0008$; *post hoc* multiple comparisons average rank test $P < 0.001$). Furthermore, in the *Educational Research* category one magazine (*Review of educational research*) has a significantly higher value for 5-Year Impact Factor in comparison to other titles. Comparison of 5-Year Impact Factor values for journals in each category of educational research are shown in Fig. 3.

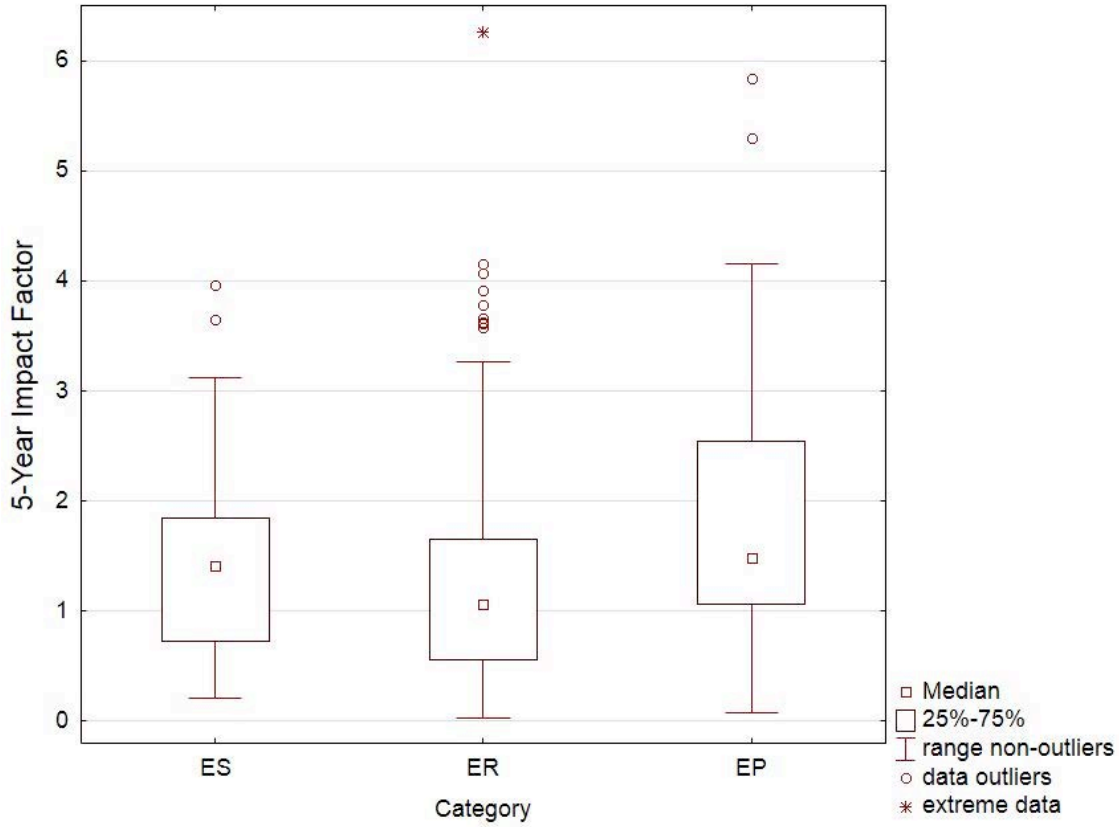

Figure 3. The 5-Year Impact Factor for journals in each category:
Education - Scientific disciplines (ES), *Educational Research* (ER), *Educational Psychology* (EP)

Analysis of the 150 most influential publications (50 in each category), representing 0.6‰ of the total number of documents indicates that their citing includes 0.5% of all investigated citations (34,743 of 680,279). For each of the three analysed categories, the group of top publication is responsible for 16% of all citations counted in all 150 articles. The structure of citations for the best 50 publications in each category showed a statically significant differences (ANOVA Kruskal-Wallis rank test H = 20.34, $P < 0.00001$). Citations of articles in the *Education - Scientific disciplines* category had statically significantly lower values (average of ranks 53.5) compared to the *Educational Psychology* and *Educational Research* categories (average of 90.9 and 82.2 ranks, respectively; *post hoc* multiple comparisons average rank test $P < 0.01$). Comparison of nine the most influential scientific publications in the field of educational research indexed by Web of Science™ Core Collection database between 2004-2014 is shown in Table 2.

Table 2. The most influential scientific publications in the field of educational research indexed by Web of Science™ Core Collection database between 2004-2014

Category	Article title	Authors	Source	Times cited
Educational Research	Computational tools for probing interactions in multiple linear regression, multilevel modelling, and latent curve analysis	Bauer D.J. Curran P.J. Preacher K.J.	Journal of Educational and Behavioral Statistics. 2006; 31(6): 437-448	789
	Bad management theories are destroying good management practices	Ghoshal S.	Academy of Management Learning & Education. 2005; 4(4): 75-91	629
	School engagement: Potential of the concept, state of the evidence	Blumenfeld P.C. Fredricks J.A. Paris A.H.	Review of Educational Research. 2004; 74(4): 59-109	546
Educational Psychology	Testing moderator and mediator effects in counselling psychology research	Barron K.E. Frazier P.A. Tix A.P.	Journal of Counseling Psychology. 2004; 51(4): 115-134	1 015
	Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching	Clark R.E. Kirschner P.A. Sweller J.	Educational Psychologist. 2006; 41(4): 75-86	624
	Emotion regulation as a scientific construct: Methodological challenges and directions for child development research	Cole P.M. Dennis T.A. Martin S.E.	Child Development. 2004; 75(6): 317-333	420
Education - Scientific disciplines	Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review	Gordon D.L. Issenberg S.B. Mcgaghie W.C. Petrusa E.R. Scalese R.J.	Medical Teacher. 2005; 27(12): 10-28	636
	Lost in knowledge translation: Time for a map?	Graham. I.D. Harrison M.B. Logan J. Straus S.E. Tetroe J.	Journal of Continuing Education in The Health Professions. 2006; 26(4): 13-24	520
	Deliberate practice and the acquisition and maintenance of expert performance in medicine and related domains	Ericsson K.A.	Academic Medicine. 2004; 79(12):S70-81	507

5 DISCUSSION

Bibliometric analysis as a part of scientometric research is a widely used tool to assess the impact of a scientist, publications, periodicals, academic institutions on the development of certain areas of science [10]. One of the most commonly used indicators for such assessment is a measurement of the number of citations (Citation Index). However, this parameter can be influenced by negative factors having a negative impact on its quality and thereby reducing the assessment accuracy of e.g. an impact of a publication or an author on development of a field of science. It means that citations of a particular publication are not only an indicator of an impact of such scientific work on the development of knowledge but they also reflect some human factors which are not associated with accepted research conventions regarding citation rules [11]. An imperfect system of scientific communication, understood as a biased (intentional or unintentional) citing of research results and achievements of other researchers, results in a state where the importance of a paper does not equal with its impact. "The impact" of a publication describes its actual impact on scientific research and direction of

development in the field in a certain time. Although, it partially depends on the number of citations, the citation can be also influenced by such factors as the location of the author, and the prestige, language, and availability of the publishing journal. Bibliometric studies published in recent years revealed that the general number of a document's citation is affected, apart from the previously mentioned, also by many other factors which should be taken into account in the assessment of the impact factor [12, 13]. Thanks to an high availability of bibliometric data and ready-to-use tools for creation of bibliometric indexes for the purpose of conducting a particular assessment, there is a risk of their improper use and erroneous conclusions. Furthermore, the fact that citations are a function of many influencing factors besides scientific quality, it is taken into consideration in the statistical analysis of citation counts for the publications of the group in question [14].

A comparison of scientists' practices on citations shows significant differences between those observed in the natural and social sciences, moreover, such differentiation is also present in various disciplines and fields of science [15, 16]. Significantly higher values of 5-Year Impact Factor in the group of journals categorized as *Educational Psychology* reveals an increased citation of publications appearing in journals on psychological research in education, relative to those which relate to the different research issues. It is clear that total citation numbers should not be compared as absolute numbers of citations are much lower for bibliographical references in works in highly specialized and theoretical fields compared to more empirical and applied fields of science [17]. For example, there are calculations for citation published by Igor Podlubny in 2005: "*one citation in mathematics roughly corresponds to 15 citations in chemistry, 19 citations in physics, and 78 citations in clinical medicine*" [17]. As Jean King rightly observes, a small number of active researchers in a field of science and a very narrow range of subjects published by a given group of journals have a significant impact on the total number of citations, which can be observed in a certain period of time [18]. It may seem that by considering only total numbers of citations in various fields of science we do not take into account the fact that the numbers of scientists working in those fields also differs significantly, as well as the total number of publications in those fields. However, the reality is the opposite: the smaller number of citations, for example, in mathematics compared to biomedicine, simply reflects the fact that the number of articles in mathematics is also smaller than the number of articles in biomedicine, that there is less people publishing in mathematics than in biomedicine, and that the average length of the reference list in mathematics is less than the average length of the reference list in biomedicine [17]. For this reason, bibliometric analysis should be carried out only in the field or area in which scientific work may be comparable in terms of the above-mentioned conditions [12].

One of the most important factors that influence the probability of citing a document are related to the international position of a journal: journal accessibility, quality/prestige of journal, visibility, and internationality [19, 20]. Van Dalen & Henkens studied the impact of potential factors that may contribute to receiving a high number of citations by a publication [20]. By analysing data from a selected group of 17 scientific journals three categories of such factors identified: the author's reputation (as producer of the idea), the journal (as the broker of the idea), and the state of uncitedness (as an indication of the assessment by the scientific community of an idea). Showed that the most important predictor of high document citation are the rank and prestige of a journal in which an article was published. On the other hand, it was found that the recognition by the scientific community of the importance of the research findings and conclusions included in the publication is of a secondary importance [20]. With reference to the above observations, obtained results of the most influential scientific publications assessed by determining the total number of citations should be treated with a large distance. When browsing through journals, attention is focused on the type of journal in which an article appears, who has written the article, whether it is a lead article or an article that is pushed to the back of a volume, etc. [20]. Highly scored journals of a high reputation a field of science by allowing publication of an article send readers message that published scientific findings are important and relevant for the development of a specific discipline. One of the important quality control mechanisms of texts send for publication in a journal is the scientific editor evaluation and *peer review*. In this system, a key element determining publication of an article is good judgment of the editor as well as an appropriate selection of qualified reviewers [21]. This problem of maintaining the prestige of a magazine by publishing high-quality articles was aptly commented by Van Dalen & Henkens: *"Picking and making winners is not only a science but apparently also an art and so the quality of the editorial board - measured by the reputation of the editors and the past performance of the journal - will impinge on the choice of articles appearing in a journal"* [20].

The high position of American university centres in the ranking of the most cited works in the field of educational research is partly related to the reputation of the author and the team of authors for the total citation of publications with academic affiliation. The achievements of an author (approximated by

his or her list of publications, the number of citations received, or prizes received), his affiliation, and country of residence are predictors of frequency of citations. Good critical analysis of the phenomenon described Robert Merton-Matthew in his paper published in *Science*, in 1968*effect in science*. Merton concludes that: *"there are increasing returns to fame"* [22]. In other words, authors with high reputations received disproportionately more citations than authors with low reputations [20]. Particularly strong impact of the reputation of the author/authors can be seen on the stage of approving an article by a prestigious journal editorial for review and the possibility to obtain peer reviews, which may be decisive at the moment of acceptance of the article for publication. For instance, if two articles of the same quality are submitted to the same journal, the article written by the more widely reputed author may be more likely to be accepted for publication than the article by a less established author. The extent to which this violation of the universalist rule occurs in the refereeing process by journals is not known. However, articles published in core journals receive considerably more citations than articles in second-tier journals and the speed with which knowledge disseminates lies far higher in the core journals than in the journals with less visibility and less reputation [20].

In the assessment of citation of individual documents a type of publication is also significant. Different types of documents published in scientific journals have a different structure of citations. Review articles are generally often cited more often than publications containing original scientific reports [23]. Other factors relevant to the potentially high number of citations are: (A) the number of co-authors, the more the higher the probability of citing of this publication [24]; (B) the number of bibliographical references in a publication is positively correlated with the number of citations of this article [25]; (c) the breadth of content, longer articles have more content that can be cited than do shorter articles [26]. Furthermore, as Kellsey & Knievel showed in their publication on citation analysis of documents in humanities, works which were published in English language are generally much more frequently cited in comparison to articles published in other languages [27]. In addition, the results of several studies suggest that the practice of scientists in the field of citations are strongly dependent on the social networks: authors cite primarily works by authors with whom they are personally acquainted. Personal bonds and familiarity affect the growth of citation which manifests in the form of increased mutual citations in the peer group [28, 29]. All the above factors should be considered when assessing the actual impact of scientific reports on the development of a field of science, not excluding bibliometric analysis presented in this paper.

Growing number of published reports is becoming more of a problem for readers of scientific publications. As aptly noted the Nobel laureate, Herbert Simon, "*A wealth of information creates a poverty of attention*" [30]. The number of articles, working papers, conference proceedings, books and newsletters is far too large for any capable scholar to absorb. In addition, changing conditions in which modern science work also contributes to the evolution of citation index as a measure for the impact of a given idea or discovery on the development of science. Along with globalization and growth of competition as well as progressing specialization, the citation index becomes the index of individual productivity of a scientist or institution [10]. Nearly 90 years after publishing in *Science* Gross & Gross article - *College libraries and chemical education*, a pioneer bibliometric study, the original function of citation ratio is changing. Understanding the changes taking place in the world of science and the conditions that affect citation should be the basis for any critical analysis of bibliographic resources regardless of the studied area of science.

6 CONCLUSIONS

Results of bibliometric analysis allow identification of research trends in education, the most important trends and interests of the scientific community in that field. Such analysis can be helpful when planning future research strategies and provide a valuable source of information for researchers seeking partners for cooperation. Organizing network research group in this case may be based on data and scientific interests of involved persons, groups or institutions coming from different countries or continents.

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